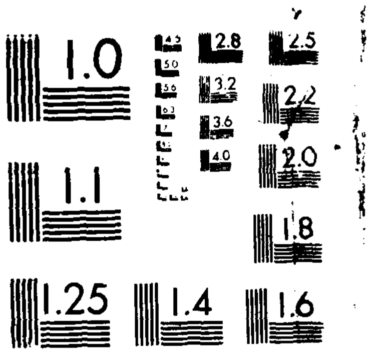
AD-A195 428 VALIDATE ALGORITHMS FOR THE DETERMINATION OF RAINFALL RATES FROM SSM/I MI..(U) WISCONSIN UNIV-MADISON SPACE SCIENCE AND ENGINEERING CENTER.. W S OLSON 05 MAY 88 1/1

UNCLASSIFIED N00014-86-K-2001 F/G 17/9 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 -

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AD-A195 428

SPACE SCIENCE AND ENGINEERING CENTER

UNIVERSITY of WISCONSIN - MADISON
1225 West Dayton Street
Madison, Wisconsin 53706

5 May 1988

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Dr. James Hollinger, Code 83-11
Naval Research Laboratory
4555 Overlook Ave., S.W.
Washington, DC 20375-5000

Dear Dr. Hollinger:

In compliance with the bi-monthly reporting requirements of Contract N00014-86-2001, entitled "Validate Algorithms for the Determination of Rainfall Rates from SSM/I Microwave Satellite Imagery", enclosed is a progress report for the months of February and March, 1988.

If you have any questions or desire further information, please contact me at (608)262-0985. Thank you for your consideration.

Sincerely,

John P. Roberts

John P. Roberts
Assistant Director

cc: Robert C. Lo, Code 7781-2 (1)
Administrative Contracting Officer, ONRRR (1)
Director, NRL (6)
Defense Technical Information Center, Code S47031 (12)
Spangler, Financial Officer (1)
Carpenter, Contracting Officer (1)
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Progress Report for February / March, 1988

Having completed all software necessary for the validation, we are performing the validation of the Hughes rain retrieval algorithm utilizing validation sites from which we have received comparative radar data. So far we have received radar data from sites in the United Kingdom; Marshall, Colorado; and Cape Canaveral Florida covering the summer and some of the fall months of 1987. Additional fall, winter and early spring validation data are on order. We will also soon be receiving radar and raingage data from the Tropical Rainfall Measuring Mission (TRMM) site at Darwin, Australia, which correspond to SSM/I overpasses of storms in January, February and March of 1988.

Based upon the recommendations of Dr. Gene Poe of NRL, and auxiliary information from James Peirce of Hughes Aircraft Co., we have made long- and cross-track shifts of the SSM/I data and derived products (EDR's) to account for data earth-location errors. Our own investigations have shown that without such adjustments, rain signatures in the satellite data do not correlate with regions of precipitation, which often are relatively small-scale. Earth-location errors have been observed to be as great as 25 km downtrack and 12.5 km cross-track (in the direction of scan motion) in the U.K. region on ascending passes, based upon comparisons with coastline geography.

It was determined from independent comparisons to geographic data that our adjustments for earth-location errors in the satellite data did not cause the Huges software to misclassify land areas as ocean areas or vice versa (see Table 1).

The following is a synopsis of validation results based upon the renavigated satellite data.

Validation Results

An intercomparison of SSM/I-derived rain rates and radar rain rates was made for 19 SSM/I overpasses of radars in the United Kingdom network. The results of these intercomparisons are presented in Figs. 1 and 2 and Table 2. Figures 1 and 2 show scatterplots of SSM/I rain rate estimates versus radar rain rates for SSM/I scenes over land and ocean, respectively.

It may be noted from the figures that only a small percentage of estimated rainfall rates for either land or ocean fall outside the ± 5 mm/hr error bounds specified in the *SSM/I User's Guide*. However, only a small percentage of sample points correspond to regions where the rainfall rate was moderate or heavy. Out of 1052 all-channel scenes collocated with radar over land, only 13 scenes contained rain for which the Hughes retrieval algorithm and the radar indicated an intensity ≥ 1 mm/hr. Over the ocean, only 14 out of 655 total scenes were associated with a Hughes rain rate estimate and a radar rain rate ≥ 1 mm/hr.

Because the distribution of rainfall rates in both the land and ocean samples is highly

skewed towards light rainfall, the statistics in Table 2 were compiled for both the entire sample sets and for scenes for which the rainfall rate (both estimated and radar-derived) was greater than or equal to 1 mm/hr. The correlation between the Hughes rain rate estimates and the radar-derived rain rates was .374 over the entire sample of data over land. A regression fit to the same sample of data yielded a slightly greater correlation (.409). For rainfall rates ≥ 1 mm/hr, Table 2 indicates a fairly high correlation (.787) between the rain rates obtained from the Hughes algorithm and the radar rain rates over land, which is again exceeded narrowly by a regression fit to the same data (.832).

Over the ocean, the correlation between the Hughes algorithm rain rate estimates and the radar rain rates was .357 , and .336 for rain rates ≥ 1 mm/hr. A regression fit to the data yielded a correlation of .624, and a correlation of .935 for rain rates ≥ 1 mm/hr. Since the step-wise regression routine selected the 85.5 GHz brightness temperatures as important rain rate predictors over the ocean, and since neither of the 85.5 GHz channels were included in the Hughes oceanic rain algorithm, we conclude that by utilizing the 85.5 GHz data an improved rain retrieval algorithm could be obtained.

Without the 85.5 GHz v channel the correlation between the regression rain rate estimate and the radar rain rate is reduced over land (.409 to .397; .832 to .831 for rain rates ≥ 1 mm/hr) and over ocean (.624 to .558; .935 to .800 for rain rates ≥ 1 mm/hr).

Plan

We will continue to add to our data base of merged SSM/I and calibrated radar data. For each climatic zone / season / surface type, our ultimate goal is to collocate at least 60 SSM/I all-channel scenes with radar where the rainfall rate is ≥ 1 mm/hr. Statistical analyses will be performed as a function of a minimum rainfall rate threshold (i.e. 0, 0.5, 1.0, 1.5 mm/hr). In addition, more extensive analyses of the precipitation and meteorological environment of severe weather events (tropical cyclones; squall lines) will be performed for a few outstanding cases. Auxiliary data from surface observations, rawinsonde reports, aircraft radar, and/or other satellite sensors will be utilized in the analysis of these severe weather events.

Table 1. If all radar bins within a 625 km^2 area centered on a given all-channel SSM/I scene are classified as over land using our land/ocean bitmap, and the nearest bitmap-determined ocean all-channel scene is at least D km away from the scene in question, then the following is the distribution of scenes classified by SURTYP:

original SSM/I navigation:

D[km]	LAND SURTYP=0	OCEAN SURTYP=5	COAST SURTYP=6
0	1314	0	407
25	1303	0	348
50	1180	0	56

renavigated SSM/I:

D[km]	LAND SURTYP=0	OCEAN SURTYP=5	COAST SURTYP=6
0	1303	0	414
25	1289	0	351
50	1146	0	87

If all radar bins within a 625 km^2 area centered on a given all-channel SSM/I scene are classified as over ocean using our land/ocean bitmap, and the nearest bitmap-determined land all-channel scene is at least D km away from the scene in question, then the following is the distribution of scenes classified by SURTYP:

original SSM/I navigation:

D[km]	LAND SURTYP=0	OCEAN SURTYP=5	COAST SURTYP=6
0	0	643	148
25	0	606	118
50	0	411	13

Table 1. (continued)

renavigated SSM/I:

D[km]	LAND SURTYP=0	OCEAN SURTYP=5	COAST SURTYP=6
0	0	600	182
25	0	564	138
50	0	414	25

Table 2. The following are statistics based upon collocated SSM/I all-channel scenes and rain rates derived from the United Kingdom network of radars during August, 1987. Classification of all-channel scenes as being over land or ocean was determined from the SURTYP classification stored with the SSM/I data. Scenes associated with flagged EDR's (out of bounds or indeterminate) were not included in this analysis. Radar-derived rain rates were area-averaged over 625 km^2 areas centered on the all-channel scenes to produce validation data.

Land (SURTYP=0):

Case	# scenes	mean rain rate [mm/hr]	bias [mm/hr]	r.m.s.e.[mm/hr]	correlation coefficient
A	1052	.17	.0323	.86	.374
B	1052	.17	-.0138	.70	.409
C	1052	.17	.0159	.70	.397
D	13	3.44	.1031	2.22	.787
E	13	3.44	-.0176	1.97	.832
F	13	3.44	-.4693	2.03	.831

Ocean (SURTYP=5):

Case	# scenes	mean rain rate [mm/hr]	bias [mm/hr]	r.m.s.e.[mm/hr]	correlation coefficient
G	655	.22	-.0340	1.12	.357
H	655	.22	-.0030	.78	.624
I	655	.22	.0106	.82	.558
J	14	4.42	-.7035	3.16	.336
K	14	4.42	.0170	1.15	.935
L	14	4.42	-.0185	1.96	.800

Cases:

A,G: EDR rain rate vs. radar.

B,H: multiple linear regression considering all channels vs. radar.

C,I: multiple linear regression considering all channels except 85.5 v vs. radar.

D,J: EDR rain rate vs. radar; only rain estimates and radar rain rates ≥ 1 mm/hr considered.

E,K: multiple linear regression considering all channels vs. radar; only rain estimates and radar rain rates ≥ 1 mm/hr considered.

F,L: multiple linear regression considering all channels except 85.5 v vs. radar; only rain estimates and radar rain rates ≥ 1 mm/hr considered.

FINANCIAL PROGRESS REPORT

February 1988 - March 1988

Progress Period

CONTRACT NUMBER: N00014-86-K-2001

DESCRIPTION OF EFFORT: Validate Algorithms for Determination of Rainfall Rates from SSM/I Microwave Satellite Imagery

PROGRAM MANAGER: William S. Olson **PHONE NUMBER:** (608)263-4085

FUNDS ALLOCATED:	289,998.00
FUNDS ON CONTRACT:	360,643.00
$ AMT THIS VOUCHER:	0
CUMULATIVE $ AMT VOUCHERS SUBMITTED:	287,684.95
BALANCE:	2,313.05
COST THRU TECHNICAL REPORT PERIOD NOT VOUCHERED:	43,397.89

Signature/Date

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DATE
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